BAYER CROPSCIENCE LP AND NICHINO AMERICA, INC.
PREHEARING EXCHANGE

EXHIBIT LIST

Exhibit Number	Description
	Exhibits Previously Produced in Support of Registrants' Motion for Accelerated Decision
PBNX 7	Notices of Registration for Flubendiamide Technical (EPA Reg. No. 71711-26) and Belt® SC Insecticide (EPA Reg. No. 264-1025) (Aug. 1, 2008)
PBNX 8	Letter from Lois Rossi (EPA Registration Division) re Preliminary Acceptance of Flubendiamide Registrations (July 31, 2008)
PBNX 9	EPA Flubendiamide Pesticide Fact Sheet (Aug. 1, 2008)
PBNX 10	Letter from Richard Gebken (EPA Registration Division) re Extension of Flubendiamide Registrations to Aug. 31, 2015 (July 18, 2013)
PBNX 11	Email from Carmen Rodia (EPA Registration Division) re Draft List of Required Additional Studies for Flubendiamide (Aug. 4, 2015)
PBNX 12	Letter from Richard Gebken (EPA Registration Division) re Extension of Flubendiamide Registrations to Dec. 10, 2015 (Aug. 26, 2015)
PBNX 13	Letter from Richard Gebken (EPA Registration Division) re Extension of Flubendiamide Registrations to Dec. 18, 2015 (Dec. 8, 2015)
PBNX 14	Email from Dana Sargent (Bayer CropScience LP) re Change in Flubendiamide Ecotoxicity Endpoint (Dec. 16, 2015)
PBNX 15	Letter from Richard Gebken (EPA Registration Division) re Extension of Flubendiamide Registrations to Jan. 15, 2016 (Dec. 18, 2015)
PBNX 16	Letter from Richard Gebken (EPA Registration Division) re Extension of Flubendiamide Registrations to January 29, 2016 (Jan. 14, 2016)
PBNX 17	Letter from Jack Housenger (EPA Office of Pesticide Programs) re Request for Voluntary Cancellation of Flubendiamide Registrations (Jan. 29, 2016)
PBNX 18	Letter from Dana Sargent (Bayer CropScience LP) re Refusal to Request Voluntary Cancellation of Flubendiamide Registrations (Feb. 5, 2016)

Exhibit Number	**Description**
PBNX 19	EPA Press Release, EPA Moves to Cancel the Insecticide Flubendiamide (Mar. 1, 2016)
PBNX 20	Flubendiamide; Notice of Intent to Cancel Pesticide Registrations, 81 Fed. Reg. 11,558 (Mar. 4, 2016)
PBNX 21	EPA BEAD Public Interest Finding for Flubendiamide (Apr. 15, 2008)
PBNX 22	Bayer CropScience LP, A Benefits Document Supporting the Continued Registration of Flubendiamide (May 20, 2015)
PBNX 23	EPA BEAD Review of Bayer CropScience LP Flubendiamide Benefits Document (July 24, 2015)
PBNX 24	Bayer CropScience LP, White Paper: Flubendiamide Benefits, Aquatic Risk Assessment Summary and Proposed Path Forward (June 29, 2015)
PBNX 25	EPA EFED Response to Bayer CropScience LP White Paper (July 15, 2015)
PBNX 26	Letter from Jerry Baron (IR-4) re Comments on Flubendiamide Notice of Intent to Cancel (Mar. 28, 2016)
PBNX 27	EPA EFED Risk Assessment for the Section 3 New Chemical Registration of Flubendiamide (June 23, 2008)
PBNX 28	EPA EFED Risk Assessment for Legume Vegetable and Christmas Tree New Uses for the Insecticide Flubendiamide (May 17, 2010)
PBNX 29	EPA EFED Ecological Risk Assessment for the New Use of Flubendiamide on Alfalfa and Certain Other Crops (Dec. 16, 2010)
PBNX 30	EPA Decision Memorandum for Flubendiamide Cancellation (Jan. 29, 2016)
PBNX 31	EPA EFED Flubendiamide Ecological Risk Assessment Addendum (Jan. 28, 2016)
PBNX 32	EPA EFED Addendum to Clarify Invertebrate Terminology in Ecological Risk Assessment Addendum (Jan. 29, 2016)
PBNX 33	Des-iodo Spiked Water Study Data Evaluation Record (May 21, 2008)
PBNX 34	Des-iodo Spiked Sediment Study Data Evaluation Record (July 19, 2011)
PBNX 35	EPA EFED Review of Three Reports re Three-Year Flubendiamide Water Monitoring Project (Feb. 20, 2015)

Exhibit Number	**Description**
PBNX 36	EPA EFED Response to Bayer CropScience LP Aquatic Risk Email Submission (July 8, 2015)
PBNX 37	Ames Herbert Curriculum Vitae
PBNX 39	2016 Insect Control Guide For Agronomic Crops (Mississippi State University Extension Publication 2471, 2016)
PBNX 40	Ames Herbert, Virginia Soybeans: Pyrethroid Resistance Hits High Levels, So Understand Treatment Options (AgFax Aug. 20, 2012)
PBNX 41	United States Department of Agriculture, Preventing or Mitigating Potential Negative Impacts of Pesticides on Pollinators Using Integrated Pest Management and Other Conservation Practices, Agronomy Technical Note No. 9 (Feb. 2014)
PBNX 42	D. Ames Herbert, Jr., and Michael Flessner, Pest Management Guide Field Crops 2016 (Virginia Cooperative Extension Publication 456-016, 2016)
PBNX 43	Dwayne Moore Curriculum Vitae
PBNX 44	EFED Memorandum re Toxicity Testing and Ecological Risk Assessment Guidance for Benthic Invertebrates (Apr. 10, 2014)
PBNX 45	OECD Guidelines for the Testing of Chemicals, Test No. 219: Sediment-Water Chironomid Toxicity Test Using Spiked Water (Apr. 13, 2004)
PBNX 46	OECD Guidelines for the Testing of Chemicals, Test No. 218: Sediment-Water Chironomid Toxicity Test Using Spiked Sediment (Apr. 13, 2004)
PBNX 47	European Commission, Working Document: Guidance Document on Aquatic Toxicology (Oct. 17, 2002)
PBNX 48	OECD Series on Testing and Assessment No. 54: Current Approaches in the Statistical Analysis of Ecotoxicity Data: A Guidance to Application (Excerpts) (May 9, 2006)
PBNX 49	EPA EFED Preliminary Environmental Fate and Ecological Risk Assessment for Methoxyfenozide (Excerpts) (Sept. 16, 2015)
PBNX 50	Bernard Engel Curriculum Vitae
PBNX 51	EPA, Guidance on the Development, Evaluation, and Application of Environmental Models (Excerpts) (Mar. 2009)

Exhibit Number	**Description**
PBNX 52	Existing Stocks of Pesticide Products; Statement of Policy, 56 Fed. Reg. 29,362 (June 26, 1991)

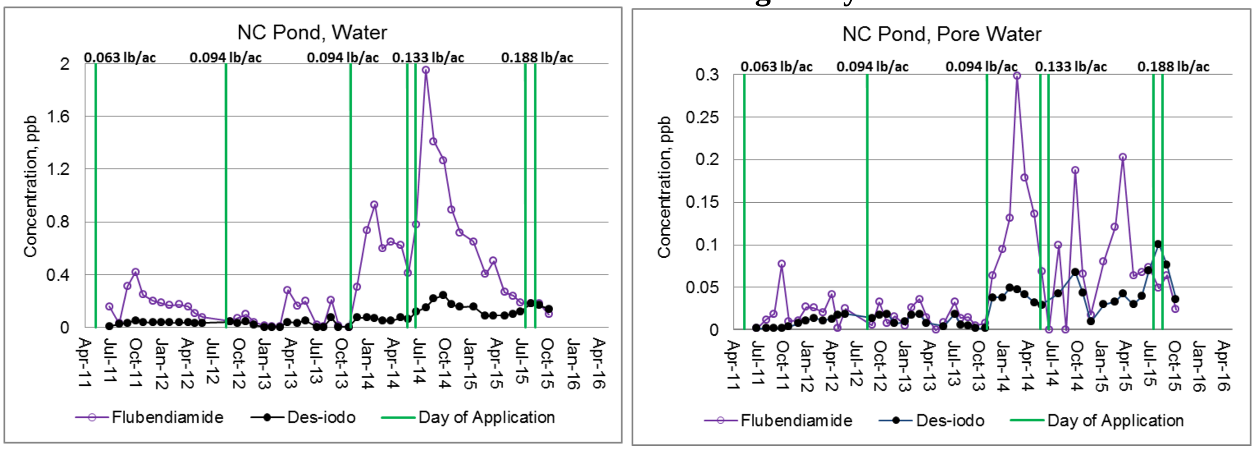
Additional Exhibits

PBNX 80	Figure 1 from Verified Written Statement of Bernard Engel: Monitoring Study Results from North Carolina and Georgia Ponds
PBNX 81	Figure 2 from Verified Written Statement of Bernard Engel: Des-iodo Concentrations in Samples Taken from Creeks/Rivers in North Carolina and Georgia
PBNX 82	Figures 3 and 4 from Verified Written Statement of Bernard Engel: Map of Flubendiamide Detections in USGS and Registrant Surface Water Samples and Map of USGS Estimated Agricultural Use for Flubendiamide in 2013
PBNX 83	Tables 1 and 2 from Verified Written Statement of Bernard Engel: NSE, PBIAS, and R^2 for EFED Models and Monitoring Data for North Carolina and Georgia Sites
PBNX 84	Table 3 from Verified Written Statement of Bernard Engel: Maximum Observed Flubendiamide and Des-iodo Concentrations Compared to Toxicity Endpoints
PBNX 100	2016 Spray Bulletin For Commercial Tree Fruit Growers (Virginia Cooperative Extension Publication 456-419, 2016) (Excerpts)
PBNX 110	John C. Palumbo Curriculum Vitae
PBNX 111	J. Palumbo, IRM Guidelines For Beet Armyworm In Lettuce Vegetable, IPM Update Archive, (The University Of Arizona Cooperative Extension Aug. 20, 2014); and Insecticide Resistance Management For Beet Armyworm In Lettuce (The University Of Arizona Cooperative Extension)
PBNX 112	John C. Palumbo, Insecticide Resistance Management Guidelines for Beet Armyworm in Lettuce, VegIPM Update, Vol. 1 No. 19 (The University Of Arizona in collaboration with the Insecticide Resistance Action Committee, Sept. 2010)
PBNX 113	John C. Palumbo, 2015 Insecticide Usage on Arizona Lettuce, Yuma Agricultural Center, (The University of Arizona Vegetable IPM Update, Vol. 6, No. 12, June 10, 2015)

Exhibit Number	**Description**
PBNX 114	J. Palumbo, Systemic Efficacy Of Coragen Applied Through Drip Irrigation On Romaine Lettuce (Fall 2007)
PBNX 115	J. Palumbo, Vegetable IPM Update Archive Worms In Fall Produce, (The University Of Arizona Sept. 30, 2015); and University of Arizona, Lepidopterous Larvae Management in Desert Produce Crops, 2015 (University of Arizona Vegetable IPM Update, Vol. 6, No. 4, Feb. 18, 2015)

PBNX 80

North Carolina Monitoring Study



Georgia Monitoring Study

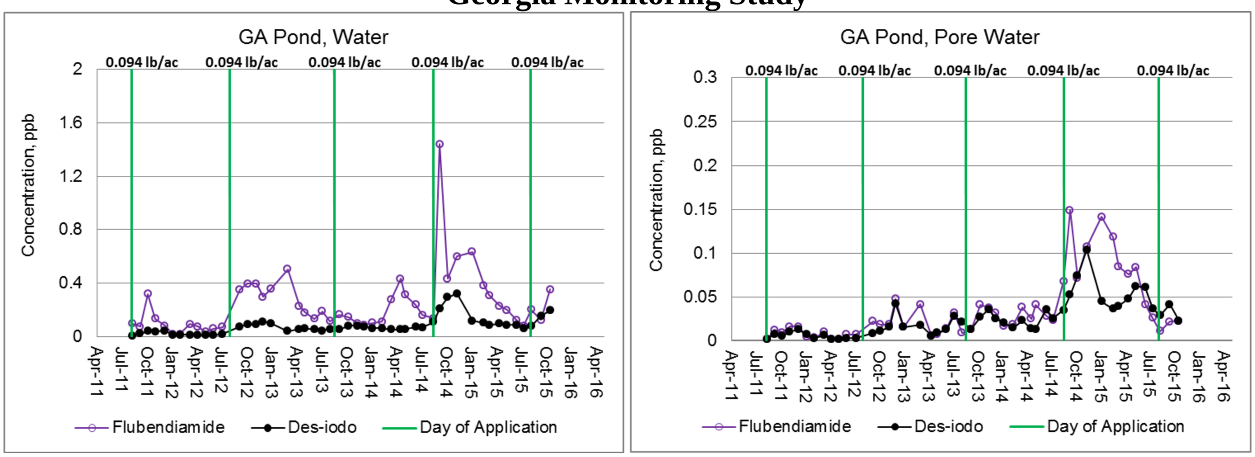


Figure 1. Monitoring results of flubendiamide and des-iodo in water column (left side) and pore water (right side) from North Carolina (top) and Georgia (bottom) ponds.

PBNX 81

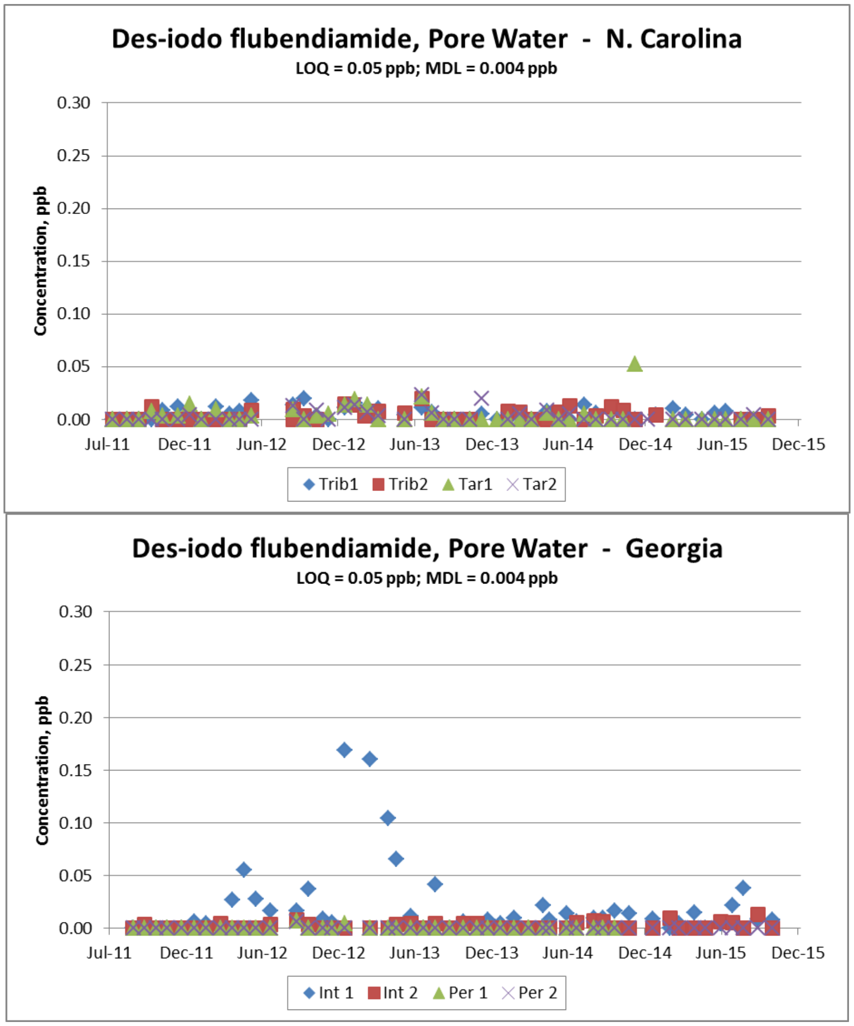


Figure 2. Des-iodo concentrations in samples taken from upstream intermittent creeks (Trib 1 / Int 1), downstream intermittent creeks (Trib 2 / Int 2), upstream perennial creeks / rivers (Tar 1 / Per 1) and downstream perennial creeks / rivers (Tar 2 / Per 2).

PBNX 82

Figure 3. Flubendiamide detections in surface water samples collected by the USGS and registrant (from EPA EFED Ecological Risk Assessment Addendum (Jan. 28, 2016), PBNX 31 at 16).

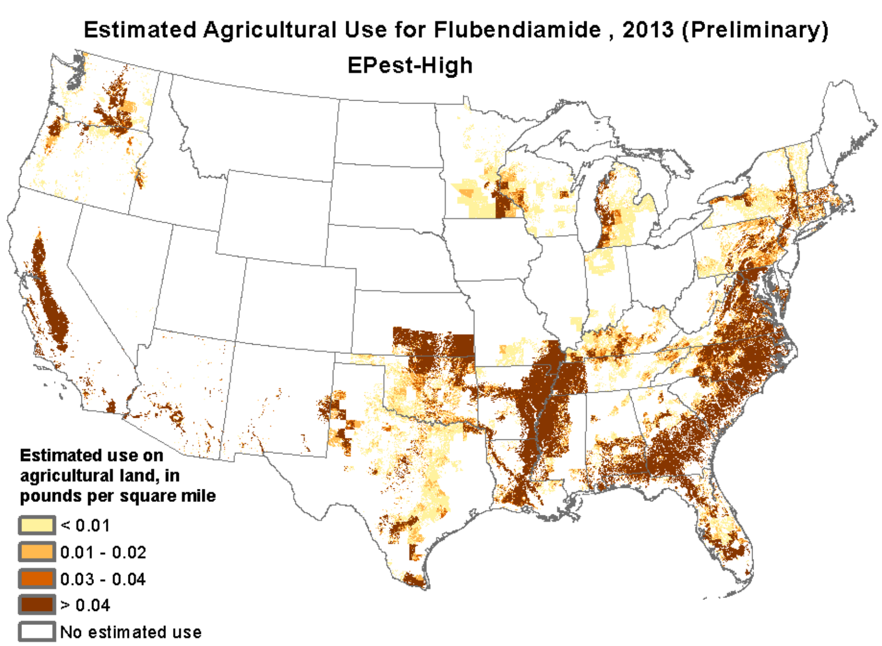


Figure 4. Estimated flubendiamide application in 2013 (from http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2013&map=FLUBENDIAMIDE&hilo=H).

PBNX 83

Table 1. NSE, PBIAS, and R^2 for North Carolina site EFED models and monitoring data.

	North Carolina Site		
Model	**NSE**	**PBIAS (%)**	**R^2**
Flubendiamide in Water Column	-0.17	66	0.15
Flubendiamide in Water Column with Flow Through	-0.24	72	0.11
Des-iodo in Water Column	-0.22	-22	0.29
Des-iodo in Water Column with Flow Through	0.10	24	0.22
Flubendiamide in Pore Water	-0.41	-89	0.16
Flubendiamide in Pore Water with Flow Through	-0.14	-59	0.11
Des-iodo in Pore Water	-11.92	-227	0.42
Des-iodo in Pore Water with Flow Through	-3.37	-127	0.35

Table 2. NSE, PBIAS, and R^2 for Georgia site EFED models and monitoring data.

	Pond 1			Pond 2		
Model	**NSE**	**PBIAS (%)**	**R^2**	**NSE**	**PBIAS (%)**	**R^2**
Flubendiamide in Water Column	-4.52	-286	0.24	-2.81	-255	0.12
Flubendiamide in Water Column with Flow Through	-0.51	-121	0.28	-0.15	-103	0.10
Des-iodo in Water Column	-41.27	-661	0.50	-40.15	-748	0.32
Des-iodo in Water Column with Flow Through	0.64	-52	0.55	0.36	-70	0.30
Flubendiamide in Pore Water	-215.65	-2100	0.57	-494.69	-2888	0.34
Flubendiamide in Pore Water with Flow Through	-63.42	-1164	0.43	-149.67	-1616	0.29
Des-iodo in Pore Water	-428.14	-2310	0.59	-2478.93	-5694	0.29
Des-iodo in Pore Water with Flow Through	-21.78	-596	0.51	-152.07	-1574	0.24

PBNX 84

Table 3. Maximum observed flubendiamide and des-iodo concentrations compared to toxicity endpoints.

Water Body		Water Column **maximum** concentration, ppb		Pore Water **maximum** concentration, ppb	
	Sampling	**Flubendiamide**	**Des-iodo flubendiamide**	**Flubendiamide**	**Des-iodo flubendiamide**
Toxicity Endpoints (NOEC / NOAEC)	*EFED*	*15.5*	*1.9*	*1.5*	*0.28*
	Bayer	*33*	*4.0*	*2.6*	*19.5*
Pond	Pond Studies	1.95	0.32	0.30	0.10
Intermittent Stream		0.62	0.05	0.19	0.17
Perennial Stream/River		0.09	0.01	0.19	0.05
Stream / River	USGS	0.93	0.07	not sampled	not sampled

Bayer NC and GA pond studies sampled monthly for 4.5 years ; USGS – 5,004 samples from national monitoring network, over 3 years, approx. monthly (not all sites for full duration)

PBNX 100

Publication 456-419

2016 Spray Bulletin for Commercial Tree Fruit Growers

Virginia, West Virginia, and University of Maryland Extension

Virginia Cooperative Extension
Virginia Tech • Virginia State University

West Virginia University

UNIVERSITY OF MARYLAND EXTENSION
Solutions in your community

PBNX 100

Table 9. Relative Toxicity of Pesticides to Orchard Predators[1]

(N=nontoxic; L=low; M=moderate; H=high; - = information is lacking)

	Mite Predators						Aphid Predators & Parasites				
	Stethorus										
Chemical	L	A	*Amblyseius*	*Zetzellia*	*Leptothrips*	*Orius*	Syrphids	Midge	Lady Beetles	Lacewings	*Aphelinus*
Acramite	N	N	M	L	-	N	-	N	N	N	-
Actara	M	M	N	N	-	M	M	M	M	M	-
Admire Pro, Pasada	M	M	N	N	-	M	M	L	M	L	H
Agri-Flex	M	M	N	N	-	M	M	M	M	M	-
Agri-Mek, Abba, Temprano	M	M	M	L	-	-	-	-	-	-	-
Aliette	-	-	-	-	-	-	H	-	-	-	-
Altacor	L	L	L	L	L	L	L	L	M	M	M
Ambush, Perm-UP, Pounce[4]	H	H	H	M	-	M	L	L	M-H	H	H
Apollo	N	N	L	L	L	N	L	N	N	N	-
Apta	-	-	-	-	-	-	-	-	-	-	-
Asana, Adjourn[4]	H	H	H	M	-	M	L	L-M	M-H	H	H
Assail	M	M	L	L	-	M	L	M	M	M	-
Avaunt	L	L	L	L	-	L	H	L	L	L	-
B.t.	L	L	L	L	L	L	L	L	L	L	L
Battalion	H	H	H	M	-	M	L	L-M	M-H	H	H
Baythroid XL	H	H	H	M	-	M	L	L-M	M-H	H	H
Belay	M	M	L	L	-	M	L	L-M	M-H	H	H
Beleaf	-	-	-	-	-	-	-	-	-	-	-
Belt	L	L	L	L	L	L	L	L	L	L	L
Bifenture	H	H	H	M	-	M	L	L-M	M-H	H	H
Calypso	M	M	L	L	-	M	L	M	M	M	-
Captan[2]	L	L	L	-	-	L	-	L	-	L	-
Carzol	M	L	H	-	-	-	-	-	-	-	-
Centaur	-	-	-	-	-	-	-	-	-	-	-
CM Virus	N	N	N	N	N	N	N	N	N	N	N
Danitol[4]	H	H	H	M	-	M	L	L-M	M-H	H	H
Declare, Proaxis[4]	H	H	H	M	-	M	L	L-M	M-H	H	H
Delegate	N	N	L	N	N	N	M	L	L	-	H
diazinon	M	M	M	L	-	L	M	H	M	M	H
dodine	-	-	-	-	-	-	-	L	-	-	-
Endigo	H	H	H	M	-	M	M	M	M-H	H	H
Entrust	N	N	N	N	N	N	M	L	L	L	-
Envidor	-	-	M	-	-	-	-	-	-	-	-
Esteem	M	N	N	N	-	M	-	N	M	M	-
Exirel	L	L	L	L	L	L	L	L	H	H	M
Gladiator	H	H	H	M	-	M	L	L-M	M-H	H	H
glufosinate	-	-	H	-	-	-	-	-	-	-	-

[1] Pesticides that are not directly toxic to a predator may still reduce its numbers indirectly by reducing prey densities. Stethorus L and A refer to larvae and adults.
[2] Although Captan is not toxic to predators, it has been associated with increased populations of spider mites.
[3] Pheromones includes all mating disruption products.
[4] These pesticides may also increase mite populations by stimulating reproduction.

Table 9. Relative Toxicity of Pesticides to Orchard Predators[1]

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	Mite Predators						Aphid Predators & Parasites				
	Stethorus										
Chemical	L	A	*Amblyseius*	*Zetzellia*	*Leptothrips*	*Orius*	Syrphids	Midge	Lady Beetles	Lacewings	*Aphelinus*
Goal	-	-	H	-	-	-	-	-	-	-	-
Imidan	L	L	N	N	H	L	-	L	L	L	L
Intrepid	N	N	N	N	N	N	N	N	N	N	N
Kanemite	-	-	L-M	-	-	-	-	-	-	-	-
Lannate	M	M	H	M	-	M	-	H	H	M	-
Leverage	H	H	H	M	-	M	M	L-M	M-H	H	H
Lorsban, Nufos, Yuma	L	L	L	N	-	-	-	-	-	H	H
mancozeb	-	-	-	-	-	M-H	H	-	M-H	-	-
metiram	-	-	-	-	-	-	L	-	-	-	-
Movento	L	L	L	L	L	L	L	L	L	L	L
Mustang Max	H	H	H	M	-	M	L	L-M	M-H	H	H
Nealta	N	N	N	N	N	N	-	-	N	N	-
Nexter	M	M	M	L	-	M	-	L	M	L	-
oil	L	L	L	L	-	-	-	-	-	-	-
oxyfluorfen	-	-	H	-	-	-	-	-	-	-	-
paraquat	-	-	H	-	-	-	-	-	-	-	-
Pheromones[3]	N	N	N	N	N	N	N	N	N	N	-
Portal	-	-	M	-	-	-	-	-	-	-	-
Proclaim	-	-	-	-	-	-	-	-	-	-	-
Rely	-	-	H	-	-	-	-	-	-	-	-
Ridomil	-	-	-	-	-	-	-	H	-	-	-
Rimon	H	L	M	-	-	-	-	-	H	H	M
Round-Up	L	L	H	-	-	-	-	-	-	-	-
Savey, Onager	N	N	L	L	L	N	L	N	N	N	-
Sevin	H	H	M	L	-	M	H	H	H	M	H
simazine	-	-	L	-	-	-	-	-	-	-	-
Sivanto	-	-	-	-	-	-	L	-	L	L	-
sulfur	L	L	M	-	-	M	-	-	-	L	-
Supracide	-	-	-	-	-	-	-	-	-	-	-
Surround	-	-	-	-	-	-	-	-	L	-	-
thiram	-	-	-	-	-	-	-	L	-	-	-
Tombstone	H	H	H	M	-	M	L	L-M	M-H	H	H
Topsin-M	L	L	H	M	-	-	-	L	-	-	-
Tourismo	-	-	-	-	-	-	-	-	-	-	-
Vendex	L	L	L-M	H	-	-	-	L	-	H	-
Venom, Scorpion	H	H	-	-	-	-	-	-	H	-	H
Voliam Flexi	M	M	L	L	L	M	M	M	M	M	L
Voliam Xpress	H	H	M	M	-	M	L	L-M	M-H	-	-
Vydate	L	L	M-H	H	-	-	-	M	-	-	-
Warrior, Lambda-Cy, Silencer[4]	H	H	H	M	-	M	L	L-M	M-H	H	H
Zeal	L	L	M	-	-	M	-	-	L	M	-

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PBNX 110

CURRICULUM VITA

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Education

Ph.D., Entomology, Oklahoma State University, Stillwater, OK, 1989; Dissertation Title: Development of Management Strategies for Squash Bug, *Anasa tristis* (De Geer) Populations in Cucurbits;
Dissertation Director, W. Scott Fargo.

M.S., Entomology, University of Arizona, Tucson, AZ, 1985; Thesis Title: Influence of *Sphaeralcea* spp. on Survival and Reproductive Behavior of Boll Weevil, *Anthonomous grandis* Boheman, in Arizona;
Thesis Director, Theo F. Watson.

B.S., Entomology, University of Arizona, Tucson, AZ, 1982

Major Fields

The goal of my applied research/extension program is to gain a fundamental understanding of insect ecology and apply this knowledge to the development of innovative pest management strategies in vegetable cropping systems. I have ongoing projects to investigate pest-crop interactions, both in the field and laboratory. The goal of this work is to determine the relationships between insect feeding and plant injury. I have also concentrated my efforts on examining ways to monitor and sample insects on vegetable crops. The goal of this work is to quantify and statistically describe spatial distribution patterns of insect populations for the development of sampling protocols that provide precise estimates of species abundance for use in ecological research and IPM programs. Most recently, I have devoted a significant amount of effort in examining the chemical management of insects and investigating techniques to better utilize pesticides in crop production. My goals are to optimize pesticide performance by gaining a better understanding of insecticide chemistries and their interactions with the target pest and cropping system. We continually evaluate chemistries with new modes of action, as well as investigate alternative uses for existing insecticides and biological control tactics. My goals in extension have been to provide empirically-based information on the management of insect populations in vegetable crops that can be directly applied by growers throughout the southwestern United States. My extension efforts are closely associated with my applied-research program, both of which address immediate insect problems occurring in local cropping systems.

Employment

2002-Present	Research Entomologist / Extension Specialist, University of Arizona, Department of Entomology, Yuma Valley Agricultural Center, Yuma
1996 – 2002	Associate Research Entomologist/Extension Specialist (IPM Coordinator), University of Arizona, Department of Entomology, Yuma Valley Agricultural Center, Yuma
1990 – 1996	Assistant Research Entomologist / Extension Specialist, University of Arizona, Department of Entomology, Yuma Valley Agricultural Center, Yuma

Awards and Recognition

Distinguished Service to Agriculture Award, Arizona Farm Bureau Association, 10/18/2001
Distinguished Service Award, Yuma Fresh Vegetables Association, 12/1/2005

Select Publications

Palumbo, J.C., T.F. Watson, & D.K. Bergman. 1990. Globemallows, *Sphaeralcea* spp., as reproductive hosts for the boll weevil (Coleoptera:Curculionidae) in Arizona. J. Econ. Entomol. 83: 392-397.

Palumbo, J.C., W.S. Fargo, & E.L. Bonjour. 1991. Spatial dispersion patterns and sequential sampling plans for squash bug (Heteroptera:Coreidae) on summer squash. J. Econ. Entomol. 84 (6) 1796-1802.

Palumbo, J.C. 1992. Identification and occurrence of *Liriomyza* species associated with cotton in Arizona. Southwest. Entomol. 17: 69-70.

Palumbo, J.C., C.H. Mullis, & F.J. Reyes. 1994. Composition, seasonal abundance, and parasitism of *Liriomyza* (Diptera: Agromyzidae) species on Lettuce. J. Econ. Entomol. 87: 1070-1077.

Tonhasca, A., J.C. Palumbo, & D.N. Byrne. 1994. Binomial sampling plans for *Bemisia tabaci* populations in cantaloupes. Res. Popul. Ecol. 36: 159-164.

Palumbo, J.C., and D.N. Kern. 1994. Effects of imidacloprid soil treatment on colonization of *Mysus persicae* and marketability of lettuce. Southwestern Entomol. 19: 339-346.

Palumbo, J.C., A.Tonhasca, and D.N. Byrne. 1994. Sampling Plans and Action Thresholds for Whiteflies on Spring Melons, IPM Series Number 1, Publication. no. 194021. Cooperative Extension, College of Agriculture and Life Sciences, University of Arizona, Tucson, Arizona.

Palumbo, J.C. and C.A. Sanchez. 1995. Imidacloprid does not enhance growth and yield of cantaloupe in the absence of sweetpotato whitefly. HortScience 30: 997-1000.

Palumbo, J.C., A. Tonhasca, & D.N. Byrne. 1995. Evaluation of sampling methods for estimating adult sweetpotato whitefly populations in cantaloupes. J. Econ. Entomol. 88: 1393-1400.

Riley, D.G. and J.C. Palumbo. 1995 Action thresholds for silverleaf whitefly (Homoptera: Aleyrodidae) in cantaloupe. J. Econ. Entomol. 88:1733-1738.

Kerns, D.L. and J.C. Palumbo. 1995. Using Admire on Desert Vegetable Crops. IPM Series Number 5, Publication. no. 195017. Cooperative Extension, College of Agriculture and Life Sciences, University of Arizona, Tucson, Arizona.

Palumbo, J.C. and W.E. Coates. 1996. Air-assisted electrostatic application of pyrethroid and endosulfan mixtures for sweetpotato whitefly, (Homoptera: Aleyrodidae) control , and spray deposition in cauliflower. J. Econ. Entomol. 89: 970-980.

Palumbo, J.C., D.L. Kerns, C.E. Engle, C.A. Sanchez, and M. Wilcox. 1996. Imidacloprid formulation and soil placement effects on colonization by sweetpotato whitefly (Homoptera:Aleyrodidae) populations: Head size and incidence of chlorosis in lettuce. J. Econ. Entomol. 89: 735-742.

Tonhasca, A., J.C. Palumbo, D.N. Byrne. 1996. Evaluation of the power law and patchiness regression with regression diagnostics. J. Econ. Entomol. 89:1477-1484.

Williams, L, T.J. Dennehy, and J.C. Palumbo. 1996. Whitefly control in Arizona: Developing a resistance management program for imidacloprid. Resistant Pest Management 8:48-52.

Palumbo J.C., and D.L. Kerns. 1996. Melon Pest Management in the Southwestern USA. *In* E. B. Radcliffe and W. D. Hutchison [eds.], Radcliffe's IPM World Textbook, URL: http:// ipmworld.umn.edu, University of Minnesota, St. Paul, MN.

Kerns, D.L. and J.C. Palumbo. 1997. Confirm and Success: New Tools for Insect Management in Cole Crops and Leafy Green Vegetables in Arizona. IPM Series Number 10. Publication no. 197008. Cooperative Extension, College of Agriculture and Life Sciences, University of Arizona, Tucson, Arizona.

Palumbo, J. C. and D.L. Kerns. 1998. Melon Insect Pest Management in Arizona . IPM Series No. 10. Publication no. AZ 1028, Cooperative Extension, College of Agriculture and Life Sciences, University of Arizona, Tucson, Arizona.

Yee, W.L, Palumbo, J.C., N.C. Toscano, M.J. Blua, and H.A. Yoshida. 1997. Seasonal population trends and densities of *Bemisia argentifolii (*Homoptera: Aleyrodidae) on Alfalfa in southern California and Arizona. Environ. Entomol. 26: 241-249.

Kerns, D.L., J.C. Palumbo and T. Tellez. 1998. Resistance of field strains of beet armyworm (Lepidopterous : Noctuidae) from Arizona and California to carbamate insecticides. J. Econ. Entomol. 91: 1038-1043.

Kerns, D. L., M. Matheron, J. Palumbo, C. Sanches, D. Still, B. Tickes, K. Umeda, and M.Wilcox. 1999.

Guidelines for Head Production in Arizona. IPM Series Number 12. Publication number az1099. Cooperative Extension, College of Agriculture and Life Sciences, University of Arizona, Tucson, Arizona.

Palumbo, J.C., D.L. Kerns, and K.Umeda. 2000. Whitefly management on desert melons. IPM Series Number 13, Publication. no. AZ1190. Cooperative Extension, College of Agriculture and Life Sciences, University of Arizona, Tucson, Arizona.

Palumbo, J.C. 2000. Management of Aphids and Thrips on Leafy Vegetables. Cooperative Extension, College of Agriculture and Life Sciences, University of Arizona, Tucson, Arizona. ACIS http://ag.arizona.edu/crops/vegetables/insects/aphid/aphidsand thrips.html

Palumbo, J.C., N.C. Toscano, M.J. Blua and H.A. Yoshida . 2000. Impact of *Bemisia* Whiteflies (Homoptera:Aleyrodidae) on Alfalfa Growth Forage Yield and Quality . J. Econ. Entomol. 93: 1688-1694.

Palumbo, J.C., A. R. Horowitz, and N. Prabhaker. 2001. Insecticidal Control and Resistance Management for Bemisia tabaci. In S. Naranjo and P. Ellsworth (eds.), Special Issue: Challeneges and Oppotunitites for Pests Management of Bemisia tabaci in the New Century. Crop Prot. 20:835-852.

Palumbo, J.C., P.C. Ellsworth, T.J. Dennehy, and R.L. Nichols. 2003. Cross-Commodity Guidelines for Neonicotinoid Insecticides in Arizona. IPM Series 17. Publ. No. AZ1319. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. 4 pp. URL: http://cals.arizona.edu/pubs/insects/az1319.pdf

Johnson, M.W., Toscano, N.C., Palumbo, J. C. and H. Costa. 2004. Integrated Pest Management PM in Vegetables and Ornamentals in the Western United States, pp. 279-299. In: R. Horowitz and I. Ishaaya (Eds.): Insect Pest Management - Field and Protected Crops. Spinger-Verlag, Heidleberg.

Foster, R., G. Brust and J. Palumbo. 2005, Watermelon, Muskmelon and Cucumber, pp.198-215. In: R. Foster and B. Flood (eds.). Vegetable Insect Management. Meister Publishing Company, Willoughby, Ohio.

Brust, G. and J. Palumbo. 2005, Squash and Pumpkins,216-229. In: R. Foster and B. Flood (eds.). Vegetable Insect Management. Meister Publishing Company, Willoughby, Ohio.

Ellsworth, P.E., J.C. Palumbo, S.E. Naranjo, T.J. Dennehy, and R.L. Nichols. 2006. Whitefly Management in Arizona Cotton 2006. IPM Series 18. Publ. No. AZ*xxxx*. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. 4 pp. URL: http://cals.arizona.edu/ pubs/insects.pdf

Palumbo, J.C. 2006 Comparison of Sampling Methods for Estimating Western Flower Thrips Abundance in Lettuce J.C. Palumbo, J. Econ. Entomol. Submitted.

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IRM Guidelines for Beet Armyworm in Lettuce (August 20, 2014)

The beet armyworm (BAW) is the most common lepidopterous pest infesting lettuce throughout the desert southwest where larvae are most prevalent from August through November. Historically, PCAs have been able to effectively control this pest using available insecticides. Because many of the products have different modes of action (MOA) that can be alternated throughout the growing season, the rapid development of resistance by BAW to any of these insecticide compounds should not readily occur. In fact, resistance by BAW to insecticides has not been recorded in nearly 20 years in the desert as a result of the judicious usage of these insecticide chemistries. However, if an insecticide compound, or products with the same MOA, are used repeatedly for worm control in the same field, the risk of resistance increases significantly. This is particularly important with the Diamide group of insecticides (IRAC group 28) which can be applied as both foliar sprays and soil injections. With the recent registration of cyantraniliprole (Exirel and Verimark), PCAs now have eight different diamides insecticide products within the diamide chemistry (IRAC group 28) to choose from for worm control. Foliar uses include Coragen, Voliam Xpress, Voliam Flexi, Exirel, Belt and Vetica; Soil uses include Coragen, Durivo and Verimark. Applying these Diamide products to the soil at planting, and then following with foliar sprays of Dimades in the same field, can expose multiple generations of Lep larvae to the same MOA. This places increased selection pressure on populations. That's not a good way to use these products if you want them to remain effective for more than a couple of years. Since the Diamides, as well as the other products currently available (Radiant, Proclaim, Intrepid, Avaunt), are critical to effective management of worms in leafy vegetables, PCAs should consciously avoid the overuse of any of these compounds. The most effective way to delay the onset of resistance by BAW in leafy vegetables is to consider the recommendations provided in the guidelines recently prepared entitled Insecticide Resistance Management Guidelines for Beet Armyworm in Lettuce.

BAW Egg Mass and Neonates

Remember, When in Doubt . . . . . "Call Barry Tickes"

Click picture to listen to John's update 

To contact John Palumbo go to: jpalumbo@ag.arizona.edu
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For questions or comments on any of the topics please contactMarco Pena at the Yuma Agricultural Center.
College of Agriculture, The University of Arizona, Tucson, AZ.

Insecticide Resistance Management For Beet Armyworm in Lettuce

THE UNIVERSITY OF ARIZONA | COLLEGE OF AGRICULTURE AND LIFE SCIENCES | COOPERATIVE EXTENSION | Yuma Agricultural Center

John C. Palumbo, University of Arizona*, in collaboration with the* ***Insecticide Resistance Action Committee (IRAC)***

The beet armyworm (BAW), *Spodoptera exigua* (Hubner) is the most common lepidopterist pest infesting lettuce throughout the desert southwest. It is most prevalent from August through November on fall-planted vegetables, and again from April through June on spring-planted melons. Historically, lettuce growers have been able to effectively control this pest using available insecticides. Resistance by BAW to insecticides has not been recorded in nearly 20 years due to the availability and judicious usage of several new products (Fig 1). However, eight insecticide products within the diamides chemistry (IRAC group 28), all with the same mode of action (MOA) and with both soil and foliar application patterns, are now available for management of BAW in lettuce. Growers and PCAs should be aware of the differences among the insecticides and their MOA and select products with which to rotate with throughout the season. An effective resistance management for BAW in desert lettuce approach should not be difficult to implement given the number of effective insecticide products with distinctly different MOA available that can be used for management of BAW larvae throughout the season (Fig 1).

Figure 1. Reference guide for selecting insecticides for BAW on relative efficacy and IRAC mode of action.

Product	IRAC[1] MOA	Beet armyworm	Cabbage looper	*Corn earworm*	Comments*
Lannate	1A	•••	•	•••	Tank mix with another product for broad spectrum Lep activity; provides thrips control; PHI: 10 d on lettuce; Use rates above 0.75 lb AI/ac.
Lorsban	1B	•••	•	•••	Tank mix with another product for broad spectrum Lep activity; For use on cole crops, PHI: 21 d; use top of label rates if possible.
Acephate	1B	•	••	••	Tank mix with another product for broad spectrum Lep activity; PHI: 21 d on head lettuce only.
Pyrethroids	3	•	•••	•••	Tank mix with another product for broad spectrum Lep activity; PHI: varies with products ; use high labeled rates
Radiant	5	•••	•••	•••	Stand alone Lep, leafminer, and thrips control; PHI: 1 day on lettuce; Use rates at 5-7 oz depending on pest spectrum.
Proclaim	6	•••	••	•••	Stand alone Lep control; use a penetrating adjuvant ; PHI: 7 day on lettuce; use at rates above 3.6 oz; if cabbage looper present tank-mixed with a pyrethroid.
Bt (i.e. Dipel)	11B	•	••	•	Tank mix with another product for broad spectrum Lep activity, numerous Bt products available; PHI: 0 d -good spray coverage desirable
Intrepid	18A	•••	•••	••	Tank mix with another product for broad spectrum Lep activity; PHI: 1 day; good spray coverage desirable; mix with a pyrethroid for best results
Avaunt	22	•••	•••	••	Tank mix with another product for broad spectrum Lep activity; PHI: 1 day, good spray coverage desirable, use higher rates for best control
Belt	28	•••	•••	•••	Stand alone Lep control; PHI: 1 day on lettuce, Use at higher rates.
Coragen	28	•••	•••	•••	Stand alone Lep and leafminer control; PHI: 1 day for lettuce- Use at or above 5 oz. for best residual effectiveness.
Exirel	28	•••	•••	•••	Foliar only; Stand alone Lep, whitefly and leafminer control; PHI: 1 day for lettuce- Use at or above 13 oz. for best residual effectiveness.
Verimark	28	•••	•••	•••	Soil only; Stand alone Lep, whitefly and leafminer control; Use at or above 10 oz. for best residual effectiveness.
Voliam Xpress	28+3	•••	•••	•••	Stand alone Lep and leafminer control; PHI: 1 day forlettuce; Use higher rates (8 oz or > for best residual effectiveness.
Volium Flexi	28+4A	•••	•••	•••	Stand alone Lep and leafminer control; PHI: 7 day for lettuce; Has aphid activity. Use higher rates for best residual effectiveness.
Durivo	28+4A	•••	•••	•••	Soil only; Stand alone Lep and leafminer control; PHI: 30 day for lettuce; Use at 13 oz. for best residual effectiveness. Has aphid activity.
Vetica	28+16	•••	•••	•••	Stand alone Lep control; PHI: 7 day for lettuce; Has whitefly immature activity. Use at 17 oz for best residual effectiveness.

•••	Good residual control (7-14 d)
••	Marginal residual control (4-6 d)
•	Poor residual control (1-3 d)

[1] IRAC Mode of Action - for more infor go to - http://www.irac-online.org/

* always consult the label before applying any of these products

General Resistance Management Tactics

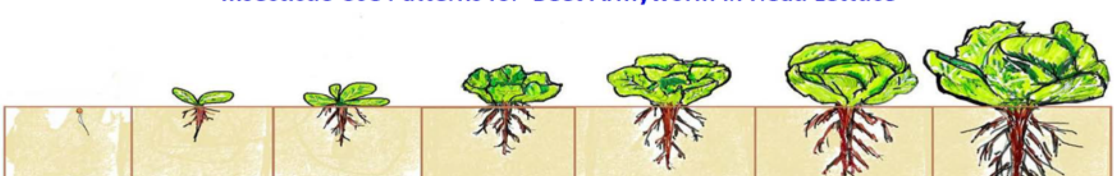
- Apply insecticides only when needed. Time insecticide applications based on UA recommended action thresholds *(http://ag.arizona.edu/crop/)*.
- Ideally, the management strategy that presents the lowest risk to insecticide resistance is one where consecutive applications of the same product **are not** made in the same lettuce field. This can be achieved by rotating to an alternative product on each subsequent spray application to eliminate consecutive uses of the same MOA .
- Practically, in lettuce fields where a product/MOA is required more than once, limit the total usage of that product to 2 applications per field per crop season.
- Use only recommended products and rates necessary to accomplish desired control.
- Whenever possible, apply insecticides by ground sprays to optimize spray deposition and coverage.

Resistance Management Tactics for the Diamides **(IRAC group 28)**

- If a dimide product is applied as a foliar spray, consider using this MOA only once per lettuce field per crop season. If a Diamide spray is required more than once, limit the total usage to 2 foliar spray per field and do not use them in consecutive applications (Figure 2).
- **Do not** spray a foliar Diamide product **prior to** or **following** the use of a soil application of chlorantraniliprole (Coragen, Durivo) or cyantraniliprole (Verimark) (Figure 3 and 4).
- If a Diamide product is soil applied at-planting, as an in-furrow spray, shank injection, or drip chemigation **do not spray** a Diamide product on that crop at any time during the remainder of the crop season (Figure 4 and 5).
- Do not apply more than **1** application of a Diamide product to the soil regardless if chemigated through drip irrigation or soil applied at planting. If additional beet armyworm control is needed during the crop season, use a non-Diamide foliar alternative (Fig 1) with an alternative MOA.
- Consider using an adjuvant with foliar Diamide applications to assist in spray atomization and penetration, and to provide uniform deposition of spray droplets on foliage.
- In areas where alfalfa or cotton is grown in proximity to lettuce, avoid using a Diamide product in alfalfa or cotton at any time.

Figure 2. **Potential use patterns for foliar applied diamides in Lettuce**

Insecticde Use Patterns for Beet Armyworm in Head Lettuce



IRAC Group	Class	Germination	Seedling	Thinning Stage	5-10 Lf Stage	11-20 Lf Stage	Head Formation	Harvest
1A/1B	OP/Carbamate		1					
5	Spinosyns			2				7
6	Abamectins						6	
18A	Diacylhydrazines					4		
22	Indoxacarb					5		
28	Dimaides, *foliar*				3			
28	Diamides, *soil*							

Figure 3 Potential use patterns for soil, at-plant applications of diamides in Lettuce

Insecticde Use Patterns for Beet Armyworm in Head Lettuce

IRAC Group	Class	Germination	Seedling	Thinning Stage	5-10 Lf Stage	11-20 Lf Stage	Head Formation	Harvest
1A/1B	OP/Carbamate							
5	Spinosyns				1			5
6	Abamectins					2		
18A	Diacylhydrazines					3		
22	Indoxacarb						4	
28	Dimaides, *foliar*							
28	Diamides, *soil*	At plant						

Figure 4 Potential use patterns for soil, drip chemigated applications of diamides in Lettuce

Insecticde Use Patterns for Beet Armyworm in Head Lettuce

IRAC Group	Class	Germination	Seedling	Thinning Stage	5-10 Lf Stage	11-20 Lf Stage	Head Formation	Harvest
1A/1B	OP/Carbamate		1					
5	Spinosyns			2				5
6	Abamectins						4	
18A	Diacylhydrazines					3		
22	Indoxacarb							
28	Dimaides, *foliar*							
28	Diamides, *soil*			Drip				

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Insecticide Resistance Management Guidelines for Beet Armyworm in Lettuce

John C. Palumbo
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in collaboration with the **Insecticide Resistance Action Committee (IRAC),** a CropLife specialist technical group

The figures below illustrate insecticide options available for chemical management of beet armyworm and other important lepidopterous larvae during the growing season. **Figure 1** provides a relative index of efficacy for insecticides currently labeled on lettuce for management of beet armyworm. The index is based on empirical data generated from local field trials. **Figure 2** offers guidance for each insecticide product and its most effective fit at various crop stages throughout the crop season.

These charts should serve as a guide to PCAs and growers for avoiding the overuse of a single product based on its IRAC defined mode of action (MOA), and as a reference for selecting products/MOAs with which to rotate throughout the season for the purpose of maximizing and sustaining product efficacy. This management approach should not be difficult to implement given the number of insecticide products with distinctly different MOA available for management of lepidopterous larvae throughout the season (Fig 1 and 2).

Figure 1.

Lepidopterous Larvae Management in Desert Lettuce Crops

YUMA

Relative Efficacy Index For Lep Larvae in Desert

Product	IRAC[1] MOA	Beet armyworm	Cabbage looper	Corn earworm	Comments*
Lannate	1A	••	•	•••	Tank mix with another product for broad spectrum Lep activity; provides thrips control; PHI: 10 d on lettuce; 7 d spinach
Acephate	1B	•	••	••	Tank mix with another product for broad spectrum Lep activity; PHI: 14-21 d on head lettuce, 7 d on cauliflower ; provides thrips control
Endosulfan	2A	•	•••	••	Tank mix with another product for broad spectrum Lep activity; PHI: 21 d for head lettuce and celery ; 7 d on cauliflower
Pyrethroids	3	•	•••	•••	Tank mix with another product for broad spectrum Lep activity; use high labeled rates; PHI: varies with products
Radiant	5	•••	•••	•••	Stand alone Lep, leafminer, and thrips control; PHI: 1 day on leafy veg and Brasscia crop groups
Proclaim	6	•••	••	•••	Stand alone Lep control; a penetrating adjuvant may enhance residual control; PHI: 7 day on leafy vegetable and *Brassica* head and stem crop groups
Bt (i.e. Dipel)	11B	•	••	•	Tank mix with another product for broad spectrum Lep activity, numerous Bt products available; PHI: 0 d -good spray coverage desirable
Intrepid	18A	•••	•••	••	Tank mix with another product for broad spectrum Lep activity; PHI: 1 day on leafy vegetable and *Brassica* crop groups -good spray coverage desirable
Avaunt	22	•••	•••	••	Tank mix with another product for broad spectrum Lep activity; PHI: 1 day on leafy vegetable and Brassica crop groups -good spray coverage desirable
Synapse	28	•••	•••	•••	Stand alone Lep control; PHI: 1 day on leafy vegetable and *Brassica* leafy crop groups
Coragen	28	•••	•••	•••	Stand alone Lep and leafminer control; PHI: 1 day for Leafy Veg crop group; 3 d for Brassica leafy crop group for both soil and foliar uses
Voliam Xpress	28+3	•••	•••	•••	Stand alone Lep and leafminer control; PHI: 1 day for head and leaf lettuce; 3 d for Brassica head and stem crop group.
Volium Flexi	28+4A	•••	•••	•••	Stand alone Lep and leafminer control; PHI: 7 day forleaf veg crop grous; 3 d for Brassica head and stem crop group. Has aphid activity.
Durivo	28+4A	•••	•••	•••	Stand alone Lep and leafminer control; PHI: 30 day forleaf veg and Brassica crop groups; Has aphid activity.
Vetica	28+16	•••	•••	•••	Stand alone Lep control; PHI: 7 day for Leafy Veg crop group; 1 d for Brassica leafy crop group. Has whitefly activity.

•••	Good residual control (7-14 d)
••	Marginal residual control (4-6 d)
•	Poor residual control (1-3 d)

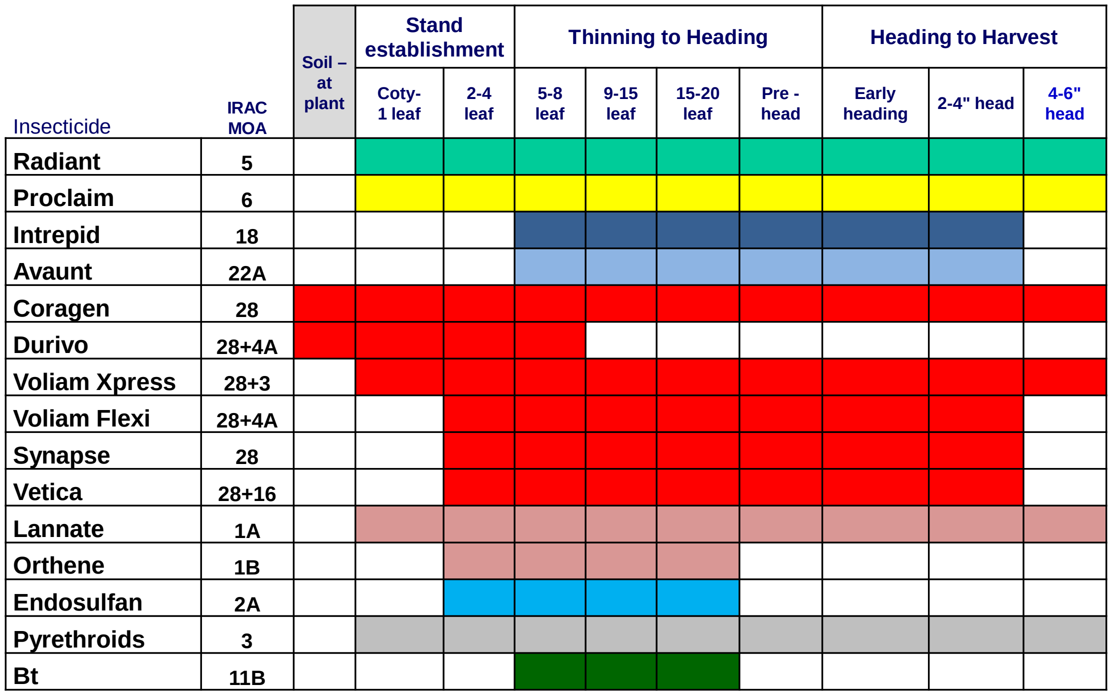
[1] IRAC Mode of Action - for more infor go to - http://www.irac-online.org/

*** always consult the label before applying any of these products**

J.C. Palumbo, VegIPM Update, Vol 1, No. 19, Sep 2010

Figure 2. **UA IPM Guidelines for Lep Management in Leafy Vegetables**

Alternatives for Lep Larvae Control by Crop Stages



****** Minimum of 4 effective MOA Effectives at any crop stage***

Additional tactics should be practiced to avoid the development of resistance by beet armyworm to any of these products/MOA as follows:

- Apply insecticides only when needed. Time insecticide applications based on UA recommended action thresholds *(http://ag.arizona.edu/crop/)*.
- Ideally, the management strategy that presents the lowest risk to insecticide resistance is one where consecutive applications of the same product/MOA **<u>are not</u>** made in the same lettuce field.
- This can be achieved by rotating to an alternative product/MOA on each subsequent spray application to eliminate consecutive uses of the same MOA (see examples in **Figure 3-5** below). Whenever possible, consider using any single product/MOA only once per lettuce field per crop season.
- In lettuce fields where a product/MOA is required more than once, limit the total usage of that product/MOA to 2 applications per field per crop season. (i.e., no more than 2 uses of any IRAC MOA or insecticide with the same color code), and avoid using it on consecutive applications.
- Use only recommended products and rates necessary to accomplish desired control (Fig 1 and 2).
- Do not apply any active ingredient below labeled rates as this may result in poor product performance, unacceptable insect damage and an increased risk of resistance.
- Apply insecticides by directed ground sprays to optimize spray deposition and coverage whenever possible.
- Do not apply tank-mixtures containing 2 or more of the <u>newer</u> chemistries (IRAC Groups - 5, 6, 18, 22 and 28) when controlling lepidopterous larvae. Not only is this expensive, but generally not necessary based on past performance trials (Fig 1).

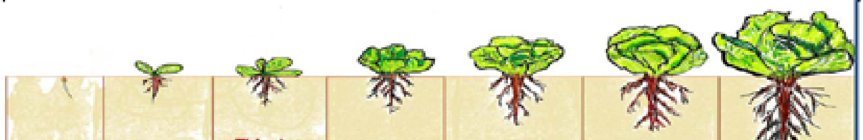
Specific resistance management recommendations have been developed for the Diamides (IRAC group 28) for *beet armyworm* on lettuce crops grown in the western U.S. Given the residual effectiveness of these compounds, along with their flexibility in application, it will be important to adhere to the guidelines below when using Diamide products as an effort to sustain the efficacy of this new class of insecticide chemistry.

- The Diamide products (IRAC Group 28) offer flexibility in application; they can be applied to plant foliage translaminarly through foliar sprays, or systemically via soil applications.
- If a Dimide product is applied as a foliar spray, consider using this MOA only once per lettuce field per crop season. If a Diamide spray is required more than once, limit the total usage to 2 foliar spray per field and do not use them in consecutive applications (Figure 3).
- **<u>Do not</u>** apply a foliar Diamide spray **<u>prior to</u>** or **<u>following</u>** the use of a soil application of chlorantraniliprole (Figure 4 and 5).
- If a Diamide product is soil applied prior-to or at-planting, as an in-furrow spray or shank injection, **<u>do not spray</u>** a Diamide product on that crop at any time during the remainder of the crop season (Figure 4).
- If a Diamide product (IRAC Group 28) is applied as a post-emergence treatment through drip irrigation, **<u>do not spray</u>** any Diamide products on that crop prior to the Diamide chemigation, or at any time thereafter during the crop season. (Figure 5).
- Do not apply more than **<u>1</u>** application of a Diamide product to the soil regardless if chemigated through drip irrigation or soil applied at planting. If additional beet armyworm control is needed during the crop season, use a non-Diamide foliar alternative. See Figures 1 and 2 for alternatives products/MOA.
- Consider using an adjuvant with foliar Diamide applications to assist in spray atomization and penetration, and to provide uniform deposition of spray droplets on foliage; this is particularly important in cole crops.
- In areas where alfalfa is grown in proximity to lettuce, <u>do not</u> apply any Diamide product (Coragen, Voliam Xpress) in alfalfa at any time.
- In areas where cotton is grown in proximity to lettuce, <u>do not</u> apply any Diamide product (Coragen) in cotton at any time.
- **<u>Do not use</u>** any soil or foliar applied Diamide product on nursery grown plants (e.g., cabbage or cauliflower) destined for field transplanting.

Figure 3

Foliar IRM Programs

Spodoptera exigua in Head Lettuce - western U.S.



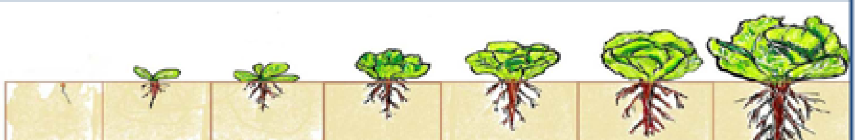
IRAC Group	Class	Germination	Seedling	Thinning Stage	5-10 Lf Stage	11-20 Lf Stage	Head Formation	Harvest
1A/1B	OP/Carbamate		1					
5	Spinosyns			2				7
6	Abamectins						6	
18A	Diacylhydrazines					4		
22	Indoxacarb					5		
28	Dimaides, *foliar*				3			
28	Diamides, *soil*							

Figure 4

Soil / Foliar IRM Programs

At planting, In-furrow

Spodoptera exigua in Head Lettuce – western U.S.



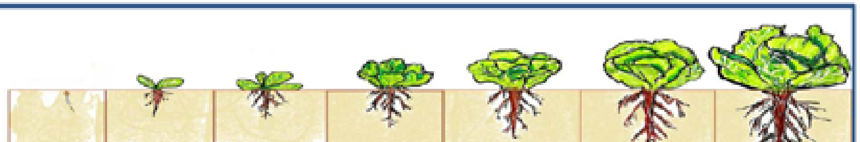
IRAC Group	Class	Germination	Seedling	Thinning Stage	5-10 Lf Stage	11-20 Lf Stage	Head Formation	Harvest
1A/1B	OP/Carbamate							
5	Spinosyns				1			5
6	Abamectins					2		
18A	Diacylhydrazines					3		
22	Indoxacarb						4	
28	Dimaides, *foliar*							
28	Diamides, *soil*	At plant						

Figure 5

Soil / Foliar IRM Programs

Drip chemigation

Spodoptera exigua in Head Lettuce – western U.S.



IRAC Group	Class	Germination	Seedling	Thinning Stage	5-10 Lf Stage	11-20 Lf Stage	Head Formation	Harvest
1A/1B	OP/Carbamate		1					
5	Spinosyns			2				5
6	Abamectins						4	
18A	Diacylhydrazines					3		
22	Indoxacarb							
28	Dimaides, *foliar*							
28	Diamides, *soil*			Drip				

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2015 Insecticide Usage on Arizona Lettuce

John C. Palumbo, Yuma Agricultural Center

Introduction: The development of accurate data on insecticide usage is important to the assessment of IPM programs in Arizona. A reliable estimate of insecticide use patterns is one of our most objective tools for assessing changes in management practices. This information allows us to build relevant databases for measuring user behaviors and adoption of new IPM technologies. For PCAs, it can translate their efforts into economic terms for their clientele and confirms their value to the lettuce industry by showing the importance of their cost-effective management in desert lettuce production. This summary provides estimates of insecticide use trends on lettuce over the past 10 years.

Methods: Growers and PCAs attended a Head Lettuce Insect Losses and Impact Assessment Workshops in Yuma on April 8, 2015 and completed surveys in a guided process. The workshops were conducted in an interactive manner where participants were given a presentation that established the incentives for participation, explained the crop insect loss system, and further walked the participants through the estimation process. This summary presents results from the insecticide use surveys for lettuce produced in Yuma County, AZ and Imperial County, CA. Data was generated by requesting that PCAs estimate the frequency of use of various products and the percentage of treated acres for each product. Estimates of total treated acreage were generated using the acreage reported from each survey participant. This data has allowed us to track changes in insecticide use patterns over time in greater detail in both fall and spring head lettuce.

Summary: A total of 19 surveys were completed in the 2015 workshop, representing an estimated total of 25,905 fall acres and 26,255 spring acres from Yuma and neighboring Imperial County (Bard/ Winterhaven) . In general, the most commonly used insecticides in fall and spring lettuce correspond directly to the key pests that typically occur during these growing periods. When compared by class of chemistry using the IRAC mode of action classification system, the pyrethroids, applied both as foliar sprays and through chemigation, are by far been the most commonly used insecticide class used in desert lettuce (Tables 1 and 2). The reason for this is quite clear: pyrethroids are one of the few inexpensive and safe broad spectrum insecticides still available for use in tank-mixtures for effective control of flea beetles, crickets, plant bugs and some Lep larvae (looper and earworm). Over the past 11 years, pyrethroid usage has remained steady (Fig 5 and 6). The overall use of OP/carbamates continues to decline and Lannate (methomyl) and acephate remain important products for thrips management (Fig 5 and 6). Their usage for Lep control is being displaced primarily by several reduced-risk chemistries. The spinosyns remain the second most commonly used class of insecticides, where greater than 95% of the lettuce acreage was treated with Radiant or Success in 2014-2015 (Table 1 and 2). Their use against both lepidopterous larvae (Figure 1) and thrips (Figure 5) has remained steady over the past 11 years. Foliar uses of Diamides (Coragen, Voliam Xpress, Vetica, Belt) were the third most commonly chemistry used in lettuce in 2014-2015 (Table 1 and 2). Since they were first registered in 2008, PCAs have steadily incorporated this new chemical class into their management programs (Fig 1). The use of Belt increased significantly this season, whereas soil uses of Coragen continue to decline (Fig 2). Ketoenol usage (Movento) on fall and spring lettuce increased this season due to heavier whitefly and aphid pressure (Figure 4). Another important class of chemistry used in fall and spring lettuce is the neonicotinoids driven primarily by soil-applied imidacloprid for whiteflies and aphids (Figures 3 and 4). The usage of imidacloprid on both fall and spring lettuce has increased markedly since 2009 and is used on almost 90% of the acreage, albeit at top of the label rates. Foliar neonicotinoid usage also increased last season, again due to heavier whitefly/aphid infestations in 2014-15. Two newer products, Sequoia and Torac, were used more frequently this season.

From an IPM perspective, the local produce industry has made great strides in minimizing environmental impacts in lettuce production by continuing to incorporate the newer reduced-risk insecticides into their insect management programs. To date there have been no been no major incidents of field failures or measurable lack of insect susceptibility with these compounds due largely to the judicious usage of the key products (e.g., conscientious rotation of chemistries). And for the fifth season in a row, PCAs treated a greater percentage of their acreage with selective, reduced-risk products than with the broadly toxic, older chemistries (Fig 6). More importantly, of the broadly toxic products used, the consumer–friendly pyrethroids were by far the predominant chemistry applied to lettuce.

Table 1. The top insecticide chemistries used on Lettuce, 2014-2015

Chemistry	Fall Lettuce, 2014			
	IRAC group	% treated acres	No. sprays	Sprayed[1] acres
Pyrethroids - Foliar	3	98.1	3.7	94,207
Spinosyns	5	92.6	2.5	59,970
Diamides- Foliar	28	100	1.1	38,098
Neonicotinoids -Soil	4A	83.9	1.0	21,734
Pyrethroids - Chemigation	3	81.3	1.0	21,601
Chitin Synthesis inhibitor	16	36.9	1.3	12,427
Neonicotinoid -Foliar	4A	40.9	1.1	11,655
OP/Carbamates	1	34.6	1.2	10,308
Avermectins	6	29.8	1.1	8492
Ketoenols	23	27.0	1.1	7694
Diamides -Soil	28	13.8	1.0	3575
Ecdysone agonsists	18	13.4	1.0	3471
Selective feeding blockers	9	6.0	1.8	2798
Sulfoxamine	4C	6.8	1.0	1762
Indoxacarb	22	0.3	1.0	78
METI I	21	0.1	1	26

Chemistry	Spring Lettuce, 2015			
	IRAC group	% treated acres	No. sprays	Sprayed acres
Pyrethroids - Foliar	3	97.7	3.3	84,649
Spinosyns	5	98.0	2.3	59,179
Diamides- Foliar	28	72.4	1.1	22,180
Neonicotinoids -Soil	4A	83.3	1.0	21,870
Ketoenols	23	46.2	1.1	13,343
OP/Carbamates	1	37.3	1.1	10,772
Neonicotinoid -Foliar	4A	30.0	1.2	9452
Pyrethroids - Chemigation	3	25.6	1.0	6721
Chitin Synthesis inhibitor	16	17.5	1	4595
Sulfoxamine	4C	14.7	1.1	4245
Selective feeding blockers	9	11.9	1.1	3437
Ecdysone agonsists	18	6.2	1	1628
Avermectins	6	5.9	1	1549
METI I	21	5.3	1.1	1531
Diamides -Soil	28	0.0	0.0	0.0
Indoxacarb	22	0.0	0.0	0.0

[1] Total acres treated estimated by multiplying : % acres treated * number of times treated * acreage estimated by participating PCAs in the 2015 survey.

Table 2. The top 12 insecticides applied to lettuce, 2014-2015

		Fall Lettuce, 2014			
	Product	**IRAC group**	**% treated acres**	**No. sprays**	**Sprayed acres**
1	**Pyrethroids -** Foliar	3	98.1	3.7	94,027
2	**Radiant**	5	89.2	2.3	53,147
3	**Imidacloprid**	4A	83.9	1.0	21,734
4	**Pyrethroids -** Chemigation	3	81.3	1.0	21,061
5	**Vetica**	28+16	36.9	1.3	12,427
6	**Voliam Xpress**	28	41.8	1.1	11,911
7	**Proclaim**	6	29.8	1.1	8492
8	**Coragen** - Foliar	28	30.5	1.0	7901
9	**Movento**	23	26.6	1.1	7580
10	**Lannate**	1	20.2	1.0	5233
11	**Belt**	28	18.3	1.1	5215
12	**Orthene (acephate)**	1	14.4	1.3	4849

		Spring Lettuce, 2015			
	Product	**IRAC group**	**% treated acres**	**No. sprays**	**Sprayed acres**
1	**Pyrethroids -** Foliar	3	97.7	3.3	86,649
2	**Radiant**	5	93.6	2.3	56,522
3	**Imidacloprid**	4A	83.3	1.0	21,870
4	**Movento**	23	46.2	1.1	13,343
5	**Voliam Xpress**	28	30.2	1.4	11,101
6	**Pyrethroids -** Chemigation	3	25.6	1	6721
7	**Orthene (acephate)**	1	17.8	1.2	5608
8	**Belt**	28	18.9	1.0	4962
9	**Lannate**	1	18.3	1.0	4805
10	**Endigo**	4A+3	11.1	1.6	4663
11	**Assail**	4A	17.5	1.0	4595
12	**Vetica**	28+16	17.5	1.0	4595

[1] Total acres treated estimated by multiplying : % acres treated * number of times treated * acreage estimated by participating PCAs in the 2015 survey.

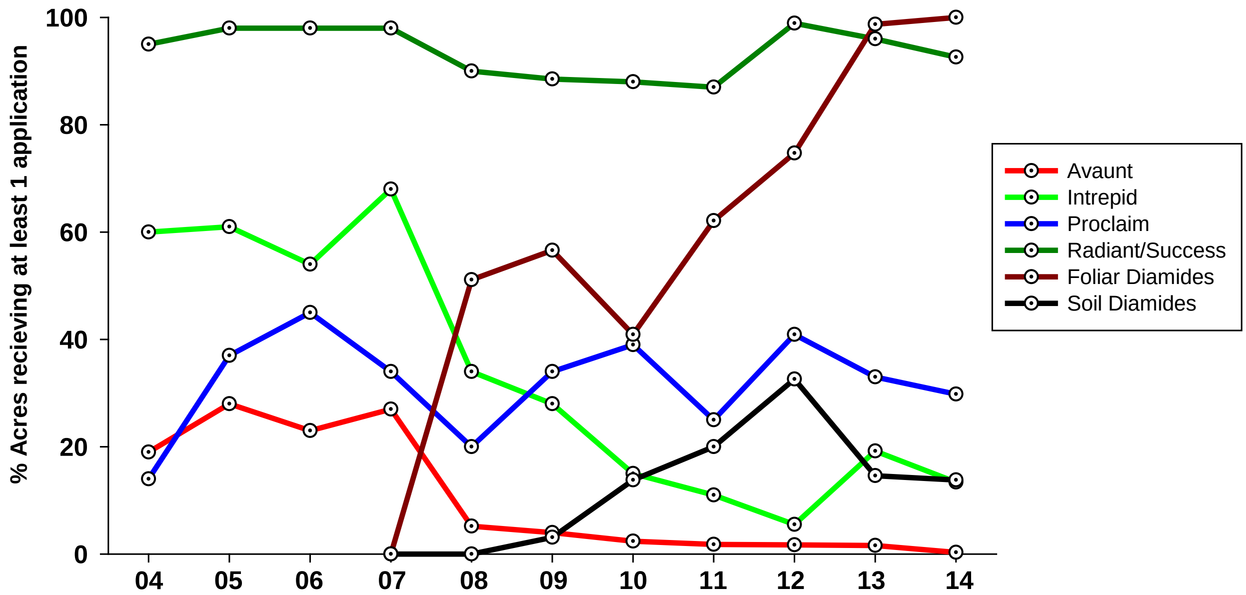

Figure 1. Trends in insecticide use for control of Lepidopterous larvae in fall lettuce, 2004-2014

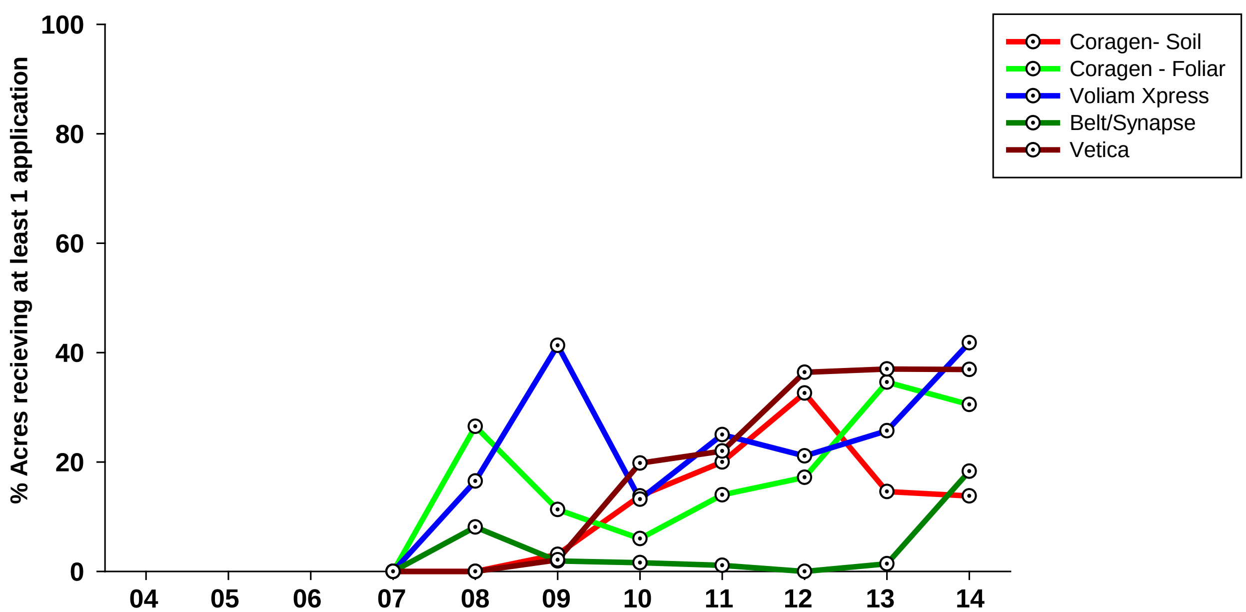

Figure 2. Trends in Diamide insecticide use for control of Lepidopterous larvae in fall lettuce, 2004-2014

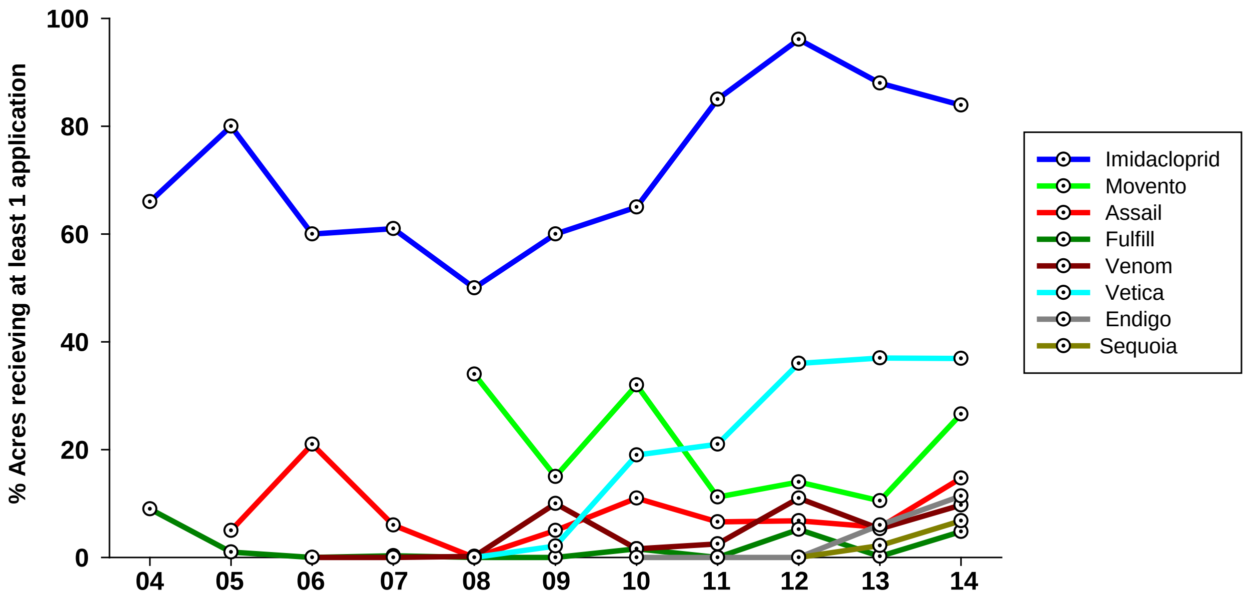

Figure 3. Trends in insecticide use for control of *Bemisia* whiteflies in fall lettuce, 2004-2014

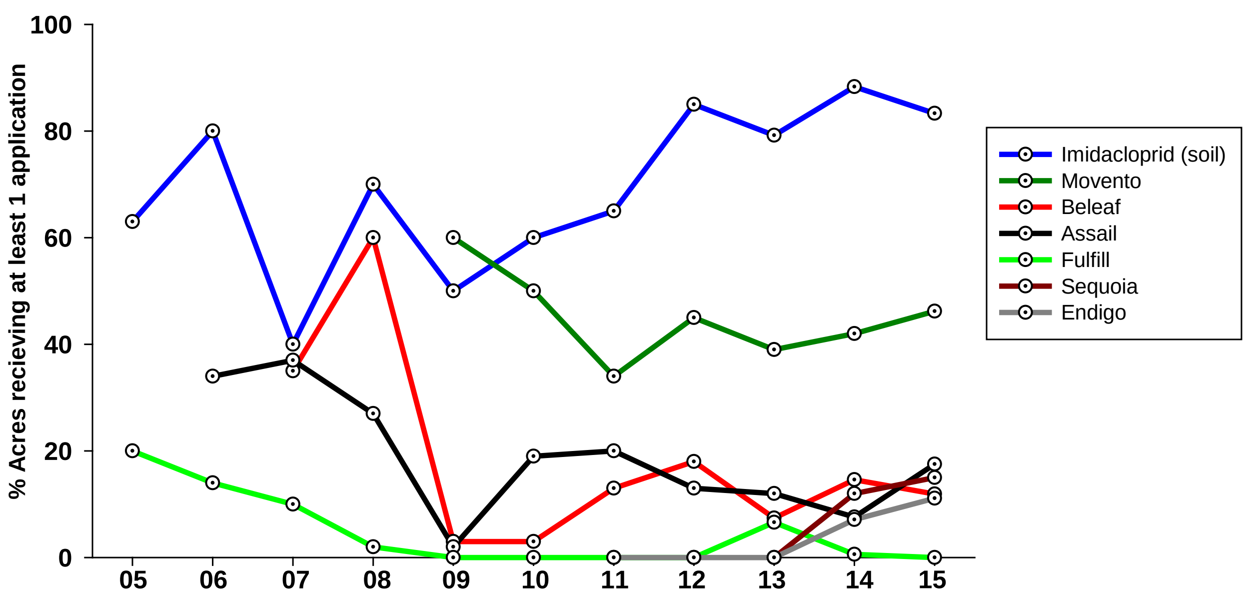

Figure 4. Trends in insecticide use for control of aphids in spring lettuce, 2005-2015

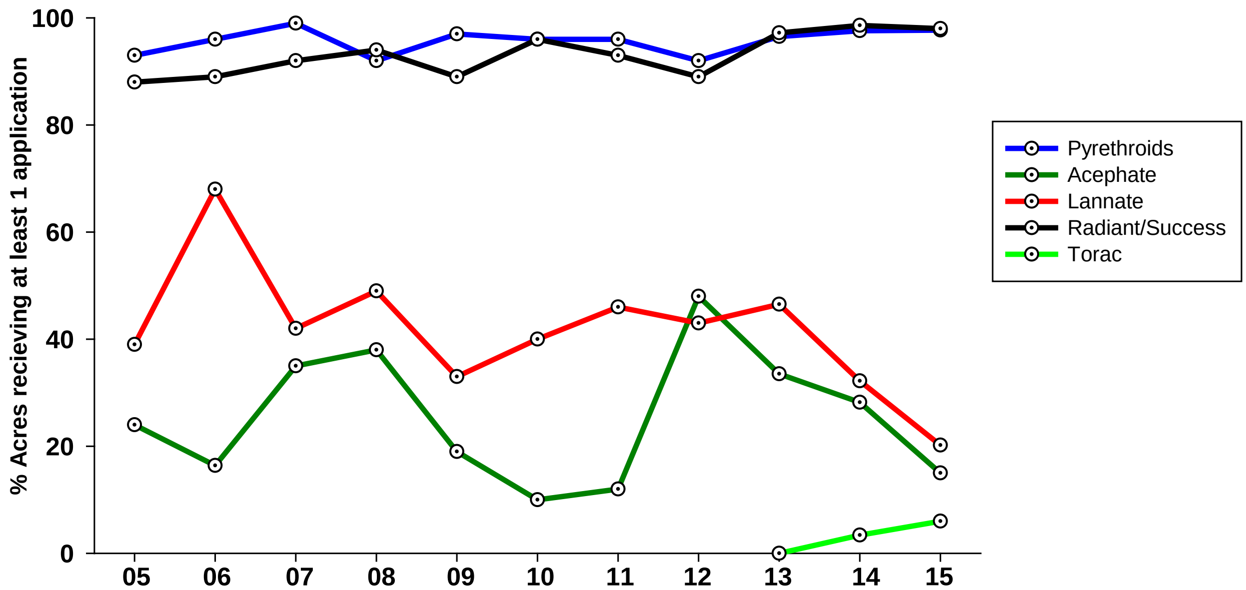

Figure 5. Trends in insecticide use for control of western flower thrips in spring lettuce, 2005-2015

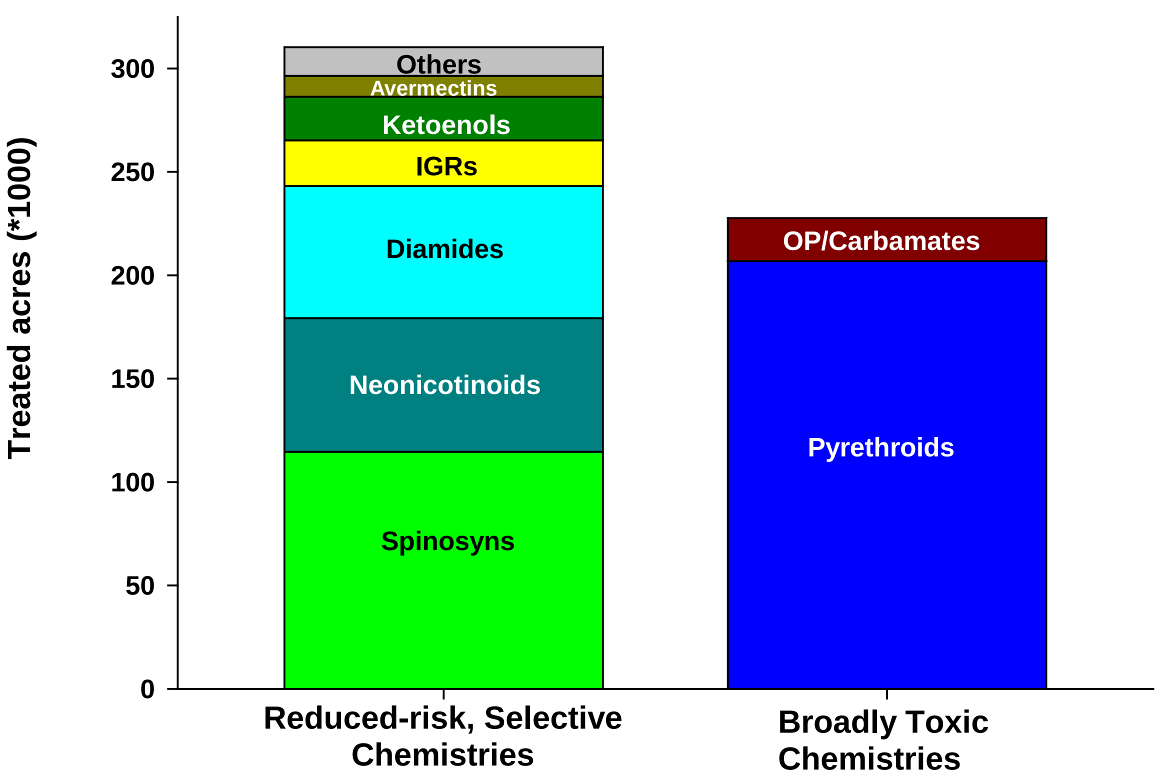

Figure 6. Total estimates of insecticide use for insect control on Lettuce , 2014-2015

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(E36)

LETTUCE (ROMAINE): *Lactuca sativa* L. var. *longifloria*, Lam. 'Fresh heart '

SYSTEMIC EFFICACY OF CORAGEN APPLIED THROUGH DRIP IRRIGATION ON ROMAINE LETTUCE, FALL 2007

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Cabbage looper (CL); *Trichoplusia ni* (Hubner)
Beet armyworm (BAW); *Spodoptera exigua* (Hubner)
Leafminers (LM); *Liriomyza* spp.

The objective of the study was to evaluate the systemic efficacy of the new compound Coragen (rynaxypyr) when applied to romaine lettuce using drip irrigation under large plot, desert growing conditions. Lettuce was direct seeded on 12 Sep 2007 at the Yuma Valley Agricultural Center, Yuma, AZ into double row beds on 42-inch centers. Stand establishment was achieved using overhead sprinkler irrigation and irrigated thereafter using a sub-surface irrigation system with emitters at 8 inch spacing; tape was placed 5 inch below the soil surface. Large plots were used in this study and consisted of a single bed, 600 ft long. Four replications of each treatment were arranged in a RCB design. Formulations and rates for each compound are provided in the tables. Treatments were applied through the drip irrigation system by diluting formulated material in 3000 ml of water and metering the total volume into the plots using a CO_2 injection system. Drip chemigations were made over a 4 h period by allowing the system to run for 1/2 h, injecting each material through the system for a 1.5 h, and then flushing the system for 2 h. A subsequent irrigation (6 h) was made 4 days following each injection. Two applications were made on 8 and 19 Oct. Evaluation of lepidopterous larvae efficacy was based on the number of live larvae per plant. Ten plants per replicate were destructively sampled on each sample date. The sample unit consisted of examination of whole plants for presence of small (neonate and 2nd instar larvae) and large (3rd or > instar) CL and BAW. At harvest (28 Nov), 20 mature plants per plot were randomly selected and assessed for presence of live larvae, feeding damage and frass on and within romaine hearts. A damage assessment of leafminer activity was conducted by counting all the visible mines present on leaves on 18 Nov (30 DAT-2). Assessments were made from 6 randomly selected plants and consisted of counting all mines on 10 leaves per plant from the basal node positions 11-20. Treatment means were analyzed using a 1-way ANOVA and means separated by a protected LSD ($P < 0.05$).

BAW and CL pressure was light-moderate. Pre-application counts were 2.0 larvae per 10 plants. At 5 days following the first chemigation, no significant differences were observed between the Coragen treatments and the untreated check (UTC) (Table 1). By 10 DAT-1, the Coragen treatments had significantly reduced larval numbers. Following the 2nd application, larvae were not detected in the Coragen treated plants for 14 days and were found at only very low numbers thereafter. At harvest (40 DAT-2), damage and larval contamination of romaine hearts was not significant in the Coragen treatments compared with the Alias and untreated check which were considerably higher than the USDA grading standards for marketable head lettuce (Table 2). In addition, assessments made at 30 DAT-2 showed that Coragen provided highly significant protection from LM (Table 3). The results of this trial further suggest that Coragen has acceptable systemic activity against key lepidopterous larvae and leafminers in lettuce when applied via sub-surface chemigation in desert growing conditions. No phytotoxicity was observed.

Table 1.

Treatment	Rate/ acre	Larvae/10 plants 5 DAT-1 Oct 13	10 DAT-1 Oct 18	8 DAT-2 Oct 27	14 DAT-2 Nov 2	21 DAT-2 Nov 9	30 DAT-2 Nov 18	40 DAT-2 Nov 28	Avg.
Coragen 1.6 SC	3.5 oz	2.5a	2.5b	0.0b	0.0b	1.0b	1.3b	0.0b	1.0b
Coragen 1.6 SC	5 oz	3.5a	0.7b	0.0b	0.0b	0.0b	0.0b	0.0b	0.6b
Coragen 1.6 SC	6.7 oz	2.1a	0.8b	0.0b	0.0b	0.0b	0.0b	0.0b	0.4b
Coragen 1.6 SC	7.7 oz	1.5a	0.7b	0.0b	0.0b	0.0b	0.0b	0.9b	0.4b
Alias 2F	16 oz	3.3a	6.5a	6.3a	5.3a	10.0a	12.5a	4.1a	6.8a
UTC	---	4.8a	7.4a	5.3a	4.4a	10.0a	13.0a	4.4a	6.9a

Means followed by the same letter are not significantly different, ANOVA; protected LSD (*P* > 0.05)

Table 2.

Treatment	Rate/ acre	Heart contamination (% infested) Feeding damage	Frass	Larvae
Coragen 1.6 SC	3.5 oz	9.4b	3.1b	0.0b
Coragen 1.6 SC	5 oz	0.0b	0.0b	0.0b
Coragen 1.6 SC	6.7 oz	0.0b	0.0b	0.0b
Coragen 1.6 SC	7.7 oz	9.4b	6.3b	6.3b
Alias 2F	16 oz	84.5a	81.5a	46.9a
UTC	---	81.5a	84.0a	43.8a

Means followed by the same letter are not significantly different, ANOVA; protected LSD (*P* > 0.05)

Table 3.

Treatment	Rate/ acre	Mines/leaf at each basal node position 11	12	13	14	15	16	17	18	19	20	Mines/ plant
Coragen 1.6 SC	3.5 oz	0.2b	0.4b	0.4b	0.3b	0.2b	0.4ab	0.3b	0.1b	0.1b	0.1b	2.3b
Coragen 1.6 SC	5 oz	0.2b	0.3b	0.1b	0.2b	0.1b	0.3b	0.2b	0.1b	0.1b	0.3ab	1.7b
Coragen 1.6 SC	6.7 oz	0.1b	0.2bc	0.2b	0.3b	0.2b	0.35b	0.1b	0.1b	0.0b	0.0b	1.3b
Coragen 1.6 SC	7.7 oz	0.0b	0.0c	0.1b	0.2b	0.1b	0.1b	0.2b	0.1b	0.0b	0.0b	0.6b
UTC	---	2.9a	2.1a	1.8a	1.5a	1.7a	0.9a	1.0a	0.6a	0.7a	0.5a	13.7a

Means followed by the same letter are not significantly different, ANOVA; protected LSD (*P* > 0.05)

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WORMS in Fall Produce (September 30, 2015)

Historically, worms (Lepidopterous larvae; -beet armyworm, cabbage looper and corn earworm) are the most important pests of desert pruduce during September and October. So, it is no surprise that worms are everywhere particularly in Dome Valley where heavy beet armyworm pressure has been reported over the past week or so. Many PCAs have reported that armyworm have been infesting lettuce as early as 8 days after wet date, which seems quicker than usual. Corn earworm larvae have also been reported in a few fields. Here at the Yuma Ag Center, one can easily find newly new egg masses and neonate beet armyworm larvae on 10 day old lettuce and broccoli stands. Cabbage loopers are beginning to show up and their populations will likely increase. Remember, temperatures drive larval development and adult moth activity, particularly when night time temps remain high (in the mid-70s or higher). The moths are nocturnal and will actively oviposit when evenings are warm and winds are light. With shorter days coming, the moths have more time to lay eggs at night. As long as the average temperature remains around 80-85°F, worms should be active at damaging levels. Those ideal conditions are consistent with the weather forecast for the next 10 days (daytime highs in the low 100's and nighttime lows in the mid 70's). Fortunately, there are a number of very effective insecticides that can be applied as stand-alone foliar products that provide effective residual control of both of these lepidopterous species. Radiant, Proclaim, Intrepid, Avaunt and any one of the Diamide products (Belt, Coragen, Exirell, Vetica, and Voliam Xpress) can provide good knockdown and extended residual control of armyworms and loopers. Addition of a pyrethroid often enhances knockdown of corn earworm and cabbage looper for many of the products. Of course, residual control will often depend on the rate applied. In general, the higher the rate, the longer the residual. But this will also depend on plant size at time of application and how fast the plant is growing. Before selecting a product for worm control, be conscious of products (chemistries) previously used on the crop. Avoid using products with the same mode of action more than twice on any given field. More information on the insecticides available for effective control of beet armyworm and cabbage looper can be found in this document: Lepidopterous Larvae Management in Desert Produce Crops, 2015..

Worms are everywhere!

Remember, When in Doubt . . . . . "SCOUT"

Click picture to listen to John's update 

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Lepidopterous Larvae Management in Desert Produce Crops, 2015

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE AND LIFE SCIENCES
COOPERATIVE EXTENSION
Yuma Agricultural Center

Product	IRAC [1] MOA	Beet armyworm	Cabbage looper	*Corn earworm*	Comments*
Lannate	1A	•••	•	•••	Tank mix with another product for broad spectrum Lep activity; provides thrips control; PHI: 10 d on lettuce; Use rates above 0.75 lb AI/ac.
Lorsban	1B	•••	•	•••	Tank mix with another product for broad spectrum Lep activity; For use on cole crops, PHI: 21 d; use top of label rates if possible.
Acephate	1B	•	••	••	Tank mix with another product for broad spectrum Lep activity; PHI: 21 d on head lettuce only.
Pyrethroids	3	•	•••	•••	Tank mix with another product for broad spectrum Lep activity; PHI: varies with products ; use high labeled rates
Radiant	5	•••	•••	•••	Stand alone Lep, leafminer, and thrips control; PHI: 1 day on lettuce; Use rates at 5-7 oz depending on pest spectrum.
Proclaim	6	•••	••	•••	Stand alone Lep control; use a penetrating adjuvant ; PHI: 7 day on lettuce; use at rates above 3.6 oz; if cabbage looper present tank-mixed with a pyrethroid.
Bt (i.e. Dipel)	11B	•	••	•	Tank mix with another product for broad spectrum Lep activity, numerous Bt products available; PHI: 0 d -good spray coverage desirable
Intrepid	18A	•••	•••	••	Tank mix with another product for broad spectrum Lep activity; PHI: 1 day; good spray coverage desirable; mix with a pyrethroid for best results
Avaunt	22	•••	•••	••	Tank mix with another product for broad spectrum Lep activity; PHI: 1 day, good spray coverage desirable, use higher rates for best control
Belt	28	•••	•••	•••	Stand alone Lep control; PHI: 1 day on lettuce, Use at higher rates.
Coragen	28	•••	•••	•••	Stand alone Lep and leafminer control; PHI: 1 day for lettuce- Use at or above 5 oz. for best residual effectiveness.
Exirel	28	•••	•••	•••	Foliar only; Stand alone Lep, whitefly and leafminer control; PHI: 1 day for lettuce- Use at or above 13 oz. for best residual effectiveness.
Verimark	28	•••	•••	•••	Soil only; Stand alone Lep, whitefly and leafminer control; Use at or above 10 oz. for best residual effectiveness.
Voliam Xpress	28+3	•••	•••	•••	Stand alone Lep and leafminer control; PHI: 1 day forlettuce; Use higher rates (8 oz or > for best residual effectiveness.
Volium Flexi	28+4A	•••	•••	•••	Stand alone Lep and leafminer control; PHI: 7 day for lettuce; Has aphid activity. Use higher rates for best residual effectiveness.
Durivo	28+4A	•••	•••	•••	Soil only; Stand alone Lep and leafminer control; PHI: 30 day for lettuce; Use at 13 oz. for best residual effectiveness. Has aphid activity.
Vetica	28+16	•••	•••	•••	Stand alone Lep control; PHI: 7 day for lettuce; Has whitefly immature activity. Use at 17 oz for best residual effectiveness.

•••	**Good residual control (7-14 d)**
••	**Marginal residual control (4-6 d)**
•	**Poor residual control (1-3 d)**

[1] IRAC Mode of Action - for more infor go to - http://www.irac-online.org/

*** always consult the label before applying any of these products**